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On-line Genomics computer laboratory with collaborative activities

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Abstract
We provide evidence that e-learning, collaborative on-line activities, and video capturing technologies are new tools to make more effective the learning of experimental science. The on-line computer laboratory in Genomics for the master degree in Biological Sciences of the University of Camerino is the case-study here discussed. This on-line laboratory allows the students to analyze gene sequences by extracting, collecting and elaborating experimental data. All the groups of students had available video tutorials on how to use on-line software to analyze gene sequences. After a period of study, each group had to solve a problem consisting in the analysis of a new gene sequence. To reach this goal the on-line laboratory included two parts: a first part with each student working alone and a second part with collaborative interactions among students of each group for the realization of a final report. The interactions included mainly the participation to forums and a wiki tool for collaborative writing. This interaction has permitted mutual assistance among students of different levels in competence and knowledge. The experimental procedure was carried out on-line by using the Moodle e-learning platform. Our results suggest that collaborative learning fosters students' ability and lead to better learning outcomes.

1. Introduction
The aim of this work is to understand if collaborative on-line activities, supported by video technologies [1], can contribute to the learning of methods and concepts of experimental sciences. At the same time, we intend to analyze the learning process of the students through their behavior in using the on-line tools of the platform. This is done to identify the optimal tools and the most effective e-learning for the on-line laboratories. This novel approach can complement laboratorial activities or theoretical classes [2]. We have realized an on-line computer laboratory of Genomics for the international master degree in Biological Sciences of Camerino University. To reproduce the collaborative environment of laboratories, we have organized an on-line collaboration, by requiring from students the realization of a final report on the results of their on-line experiments. The interaction has permitted mutual assistance among students of different levels. Experimental tasks were carried out on-line by using the Moodle platform. Final reports appeared satisfactory and detailed. Collaborative learning results to foster students' ability and lead to better learning outcomes. Our results are quantified by the data taken from Moodle, by analyzing the reports, and by a survey on the collaborative activities.

2. Methods
44 international students of Genomics of the Master degree in Biological Sciences have been divided in 12 groups, three or four students each. Group members were chosen to be heterogeneous for competence in genetics (evaluated by a test). The on-line laboratory allows students to study gene sequences. All students watched video tutorials with explanations on the software to analyze gene sequences. Each group solved a problem consisting in the analysis of a new gene sequence (not available in data bases) including the identification of the potentially encoded protein and the alignment of the new protein with evolutionary related proteins in data bases. Each group had one different sequence for a total of 12 sequences. To reach this goal, the laboratory included: a) a first part where each student worked alone writing a personal report; b) a second part with collaborative interactions among students of each group to realize a final report including and discussing the best solutions taken from the individual reports by using forum and Wiki for collaborative writing [3]. The students had 4 weeks to complete the activities: 10 days for individual elaboration, 20 days for collaborative work.

3. Results and Discussion

The platform allowed us quantitative analysis of collaboration activities carried out by students. We start analyzing the data by studying the views of videos by the 12 groups, reporting in Figure 1 the data of their views. The groups from 1 to 8 were constitued by 4 students, groups from 9 to 12 by 3. The teacher spent 6 class hours to explain activities for the laboratory of Genomics, almost all students were present. The striking result is that all groups (see exception of groups 2 and 9) decided to see again the videos. In some cases more than 20 views of the first video have been done. We conclude that on-line videos are key resources for the students. The repeated views are very useful to understand the concepts needed in the tasks.

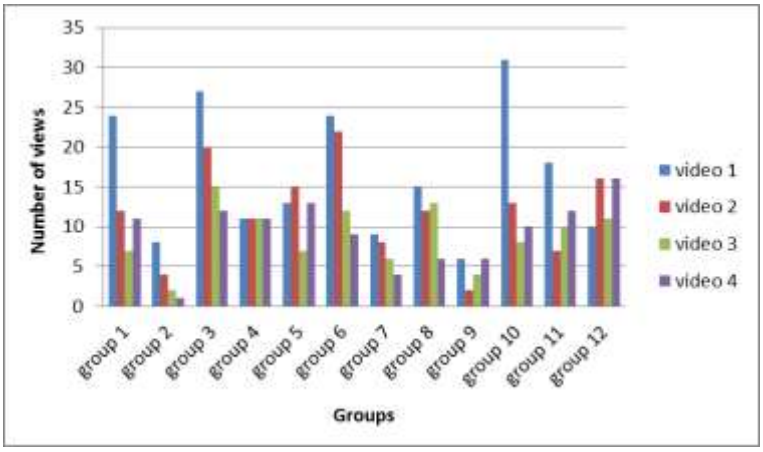

Fig.1. Views of the four explanatory videos.

We continue analyzing the forum. In Figure 2 we show for each of 12 groups the number of forum posts normalized to the students in the group as a function of the views normalized to the students in the group.

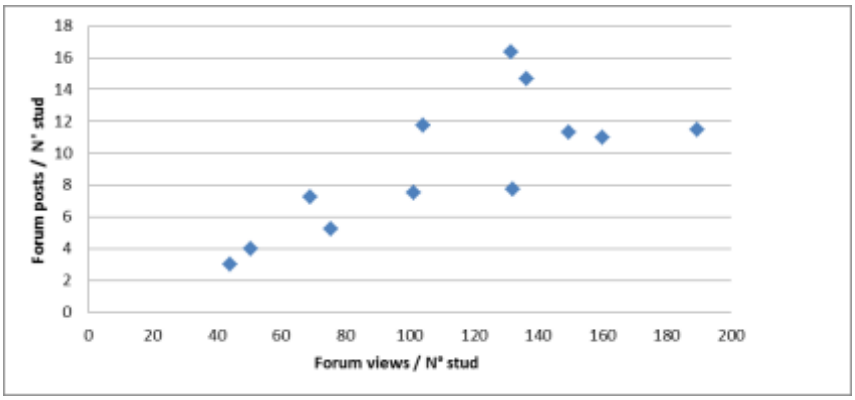

Fig.2. Number of posts in the forum as a function of number of views.

7 groups were formed by 4 students, while the other 5 groups were formed by 3 students. The forum has been widely used by all groups to realize their tasks. Views for each student are in very large number, ranging from 45 to 190. The corresponding active posts increases in a monotonic way for increasing views. The data in figure 2 follows a linear behavior for small number of views, while for a larger number of views (>100) the spread of the data increases in a sizeable way. In average we conclude that every 10 views a student decides to publish 1 post in the forum, which is reasonable considering the technical content of the genomics course.

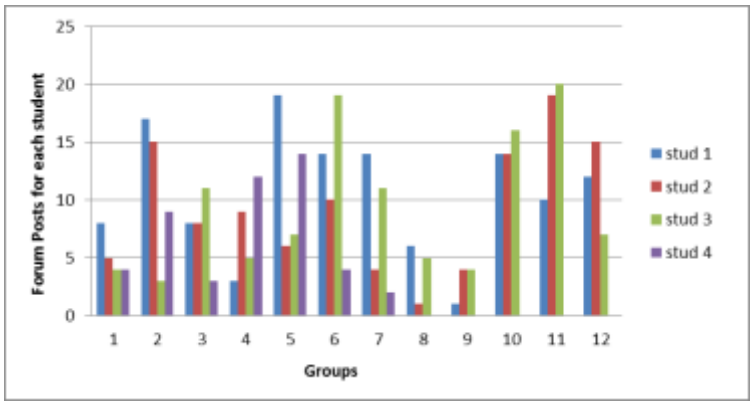

Fig.3. Posts in the forum for each student in the groups.

In Figure 3 we show the number of posts by each group, with the detail of the number of posts by each student of a given group. Except for groups 8 and 9, the number of posts is always larger than 20, with a corresponding high level of interaction in the forum. The main evidence from Figure 3 is that in all groups at least two students have been very active and they closely collaborated to exachange ideas and information to realize the tasks. For five groups it turns out that one student did not participate actively to the discussion. This is a standard outcome in a forum dynamics and we need to set actions to minimize this problem in next courses. Interestingly, in four groups (1,10,11,12) the level of interaction in the forum was equally distributed among the participants, an optimal situation for collaborative activities. The combined analysis of Figures 2 and 3 leads us to conclude that the forum has been a very appreciated and useful tool for all students.
We now pass to analyze the data from the platform on the Wiki for collaborative writing of the final report of this Genomics laboratory.

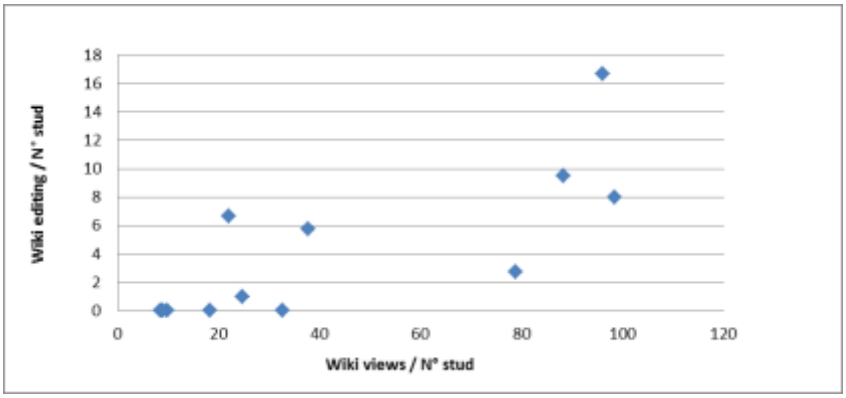

Fig.4. Number of editing in the Wiki as a function of the number of views.

In Figure 4 we show for each group the number of editings (changes in the report) recorded by the Wiki as a function of views. Each data point has been normalized to the number of students in a given group, as above. All the 12 groups have viewed the Wiki several times. But only 7 groups over a total of 12 have been used the Wiki to carry out the final report using the collaborative writings (making editings). In Figure 4 we have recorded with zero the groups that entered in the wiki without editings. Among the 7 wiki-active groups, 5 groups worked quite intensively, with at least 6 editings per student, while 2 groups used less rarely the Wiki to write the report. The data points are too scattered to extract averaged information or functional dependence.

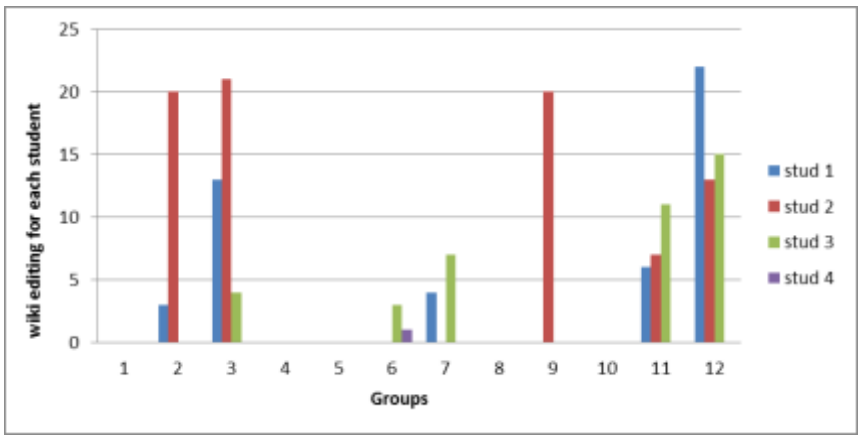

Fig.5. Number of editing in the Wiki by each student in the different groups.

In Figure 5 we show the number of editings by each student in a group. The data are normalized to the number of students in the group. All situations of collaborative experience have been observed. In groups 11 and 12 all students participed with an equal effort to the report editing. Groups 2 and 9 had only one active student. Group 3 had a mixed situation of different engagement of students. Groups 6 and 7 are charaterized by a low collaboration. We have investigated the problems encountered by students in using the Wiki through interviews. Two problems have been found: a) The Wiki tool does not allow more than one student at the same time to edit the document. This is a problem when the activity has a limited time to be concluded and students can dedicate the same evening hours to this activity. b) The students had problems in writing a report having complex tables, many figures, symbols and to highlight gene sequences. Moreover, copy and paste from an offline document to the Wiki document was challenging. Therefore, nearly half of the students did not consider the Wiki a suitable tool for handling a collaborative document with heavy scientific formatting. This can partially explain the results shown in Figure 5 on the low level of Wiki usage. The combined analysis of the data trends reported in Figures 4 and 5 leads us to conclude that the Wiki tool has been considered not easy to use. Since the forum was available as alternative tool, the groups preferred to use it to fulfill tasks. Moreover, the forum is much more common in the web, while the Wiki is less common, with the exception of a passive use of Wikipedia. We decided therefore to merge the data extracted from the forum and the Wiki in a single plot, summing for each group the active actions (Forum posts + Wiki editing) and the passive actions (Forum views and Wiki views), normalized to the students in a group.

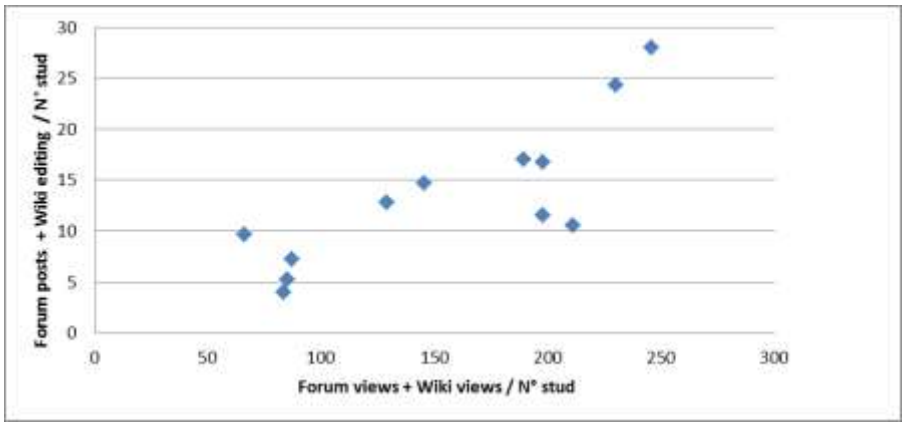

Fig.6. Sum of activities in Wiki and Forum: posts and editing as a function of views in both tools.

In Figure 6 the trend is characterized by an increase of active actions in an almost monotonic way when the number of passive actions also increases, with the exception of 3 data being outside the average trend. This is a strong evidence of the need to work with the preferred collaborative tool, or

with a combination of tools, in particular for a blended course in which the students do not have enough experience to work on-line.

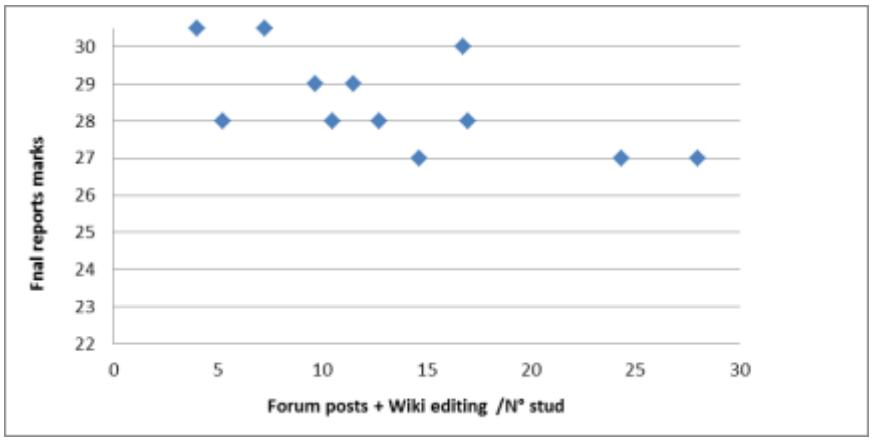

Fig.7. Final mark of the group as a function of the total editing and posts in the Wiki and forum tools.

Finally, in Figure 7 we tried to correlate the marks given by the teacher to the final report (one mark for each group work) with the merged number of editing in the forum and in the Wiki. We noted that thanks to the high level of activities done by the groups, considering also that the students have done other interactions during class, the final marks for this computer laboratory (>27 over a maximum of 30) were very satisfactory, as confirmed by the teacher. We quantify in the plot the extra bonus given to two groups with 30.5. The small range of variability of the marks, between 27 and 30.5, did not allow an extraction of a precise trend. Nevertheless, we observe a counter intuitive results: the 3 groups with the lowest mark of 27 were the ones characterized by the largest number of active actions in the platform, and also by the uniform distribution of work-load within the group. This suggests that in these groups there were no dominant students in terms of knowledge and expertise. Also suggests that students in these groups encountered difficulties that they tried to overcome by the large number of activities performed to solve the problems.

4. Conclusions

The investigation of the learning process and outcomes of the on-line computer laboratory of Genomics leads to the following results: *i*) the on-line videos have been widely used and considered by the students as key resources to understand the concepts in the tasks. Regarding the collaborative activities, *ii*) the forum has been a very appreciated tool to negotiate the final report, while *iii*) the Wiki has been considered by half of the students a complicated tool with technical problems in handling a complex scientific document. Therefore, *iv*) a combination of collaborative tools in the platform gives more opportunities to the students to find their best tool to fulfill the tasks. In next course editions, starting from the results of this work, we will set actions to minimize the mentioned problems, while we will confirm the inclusion of tools successfully used in this course.

References

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